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(54) FLUORESCENT LAMP APPARATUS

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do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to gas discharge lamps and, more particularly, it relates to mercury vapour fluorescent lamps having thereinside a quantity of a mercury amalgam, wherein the light output of the lamp is maintained at an optimum value at varying ambient temperatures by the temperature of the amalgam being maintained at an optimum level by an electric heater associated with the lamp.

Known in the art is a fluorescent lamp having an indium-mercury amalgam which is deposited as an annular strip onto the internal wall of the glass envelope of the glass envelope of the lamp, intermediate the electrodes, whereas the heater associated with said amalgam surrounds the glass envelope of the lamp, in the zone of the annular strip. The electric current supplied to the heater is controlled by a photo-electric control system.

However, with the heater and the amalgam being disposed in the central portion of the lamp, the technology of the manufacture of such lamps becomes somewhat complicated, and the operational characteristics of the system including the lamp and the heater are affected adversely. The technology of the manufacture of the lamps is complicated by the difficult operation of depositing an annular strip of the amalgam on the central portion of the internal wall of the glass envelope of the lamp, prior to assembling of the latter, by the necessity of maintaining the parameters of thermal treatment and evacuation of the lamp during its manufacture within very close limits, and so on. The operational characteristics of the system including the lamp and the associated amalgam heater are affected by rather complicated connection of the heater and the heating control system; by the light output of the lamp being reduced on account of the heater screening out a portion of this light output; by the difficulties encountered when the operation of the lamp is to be matched with that of the heater when the lamp and the heater are manufactured separately and assembled "in situ", by complicated transportation of the lamp when the manufacturer himself mounts the heater on the lamp; by considerable power losses on account of the heater dissipating a substantial amount of heat, etc.

It is an object of the present invention to alleviate at least one of the abovementioned disadvantages.

According to the present invention there is provided fluorescent lamp apparatus comprising a fluorescent lamp including a quantity of an amalgam disposed within a stem, an electric heater for heating the amalgam and surrounding the stem, and an end cap in which said heater is disposed; and control means for controlling the electric current flowing through said heater in accordance with the variations of the ambient temperature.

The present invention can provide a fluorescent lamp having the amalgam and the amalgam heater so disposed, that the manufacture of the lamp and the heater means is considerably simplified, and the operational characteristics of the lamp are improved.

Preferably the end cap comprises a base to which a metal housing is joined, one electric lead of said heater being connected to the metal housing, and another electric lead of said heater being connected to a terminal pin carried by said base.

The disposition of the amalgam heater in the end cap of the lamp considerably simplifies the technology of the manufacture of the

lamp and improves the operational characteristics of the latter.

The technology of the manufacture is simplified because when the heater is disposed in the end cap of the lamp, surrounding the stem, the amalgam can be introduced into the stem directly before the final sealing of the lamp. Thus, it becomes possible to eliminate the necessity of maintaining the parameters of thermal treatment and evacuation of the lamp within very close limits, lest these operations might affect the amalgam. It is understandable that such necessity arises when the amalgam is disposed in the central portion of the glass envelope of the lamp in the form of an annular strip, because this strip has to be deposited prior to evacuation and thermal treatment of the lamp. Moreover, the operation of introducing the amalgam into the stem of the lamp is simpler than deposition of a thin strip of the amalgam on the internal wall of the glass envelope of the lamp, centrally of the lamp.

The operational and other characteristics of the fluorescent lamp are improved because when the heater is disposed in the end cap of the lamp, transportation of such a lamp is in no way different from transportation of a lamp having no heater at all; moreover, such a lamp can be easily (without any additional leads) connected to an associated lighting fixture housing thereinside the control means, the metal housing being usable as one of the two contact leads of the heater; furthermore the heater no longer screens any portion of the light emitted by the lamp.

It is worth particular mention that with the heater mounted about the stem of the lamp and the amalgam disposed inside this stem, the optimum value of the mercury vapour pressure can be maintained by a heater of substantially smaller power, than in the case of a heater mounted about the central portion of the glass envelope, because, on the one hand, the mass of the stem being heated is very small, and, on the other hand, the temperature within the closed space in the base of the lamp is far less affected by the ambient temperature than the temperature of the central portion of the glass envelope. This reduced power requirement of the amalgam heater is advantageous not only from the point of view of increasing the efficiency of the lamp, but also on account of it becoming possible to simplify the structure of the control means.

An embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawings wherein:—

Figure 1 is a schematic longitudinal sectional view of the portion of the lamp which houses amalgam heating means;

Figure 2 is a diagram illustrating the control means and electric connections of the lamp and of the amalgam heater;

Figure 3 is a graph showing light output of a lamp constructed in accordance with the present invention, of a mercury vapour lamp having no mercury amalgam and of a lamp having an amalgam, but having no amalgam heater, against temperature.

Referring now in particular to Figure 1, the mercury-filled fluorescent lamp has a substantially cylindrical shape, and has an optimum pressure of the mercury vapour thereinside maintained by the small quantity of amalgam 1, e.g. mercury-indium amalgam, provided inside a stem 2 of the lamp, being additionally heated by an electric heater 3 which surrounds the stem 2, the degree of heating being controlled in dependence on ambient temperature. The lamp has a double-pin base 4 joined to a metal housing 5, the base 4 with the metal housing 5 together forming an end cap. A first emissive internal electrode 20 is connected by leads to terminal pins 8 and 10 mounted on the base 4. One electric lead 6 of the heater 3 is electrically connected to the metal housing 5 of the base 4, and the other electric lead 7 of the heater 3 is electrically connected to the terminal pin 8 of the lamp. Mounted inside the end cap of the lamp is an insulating tube 9 surrounding the lead connected to the terminal 10, the tube 9 providing electric insulation between that lead and the lead 6. A quantity of the amalgam 1 is retained in a desired position inside the stem 2 by means of a shoulder 11 provided in the internal bore of the stem 2, inside which the amalgam 1 is received. Alternatively, the amalgam 1 may be retained inside the stem 2 by means of a retaining bead or a fibreglass pad.

Figure 2 of the appended drawings illustrates by way of example the electric connections of a fluorescent lamp which is constructed in accordance with the invention and which is similar to that shown in Fig. 1. The lamp shown in Figure 1 may be energised by a circuit similar to that shown in Figure 2. It can be seen from Figure 2 that the heater 3 which, as has been already described, surrounds the stem 2 receiving thereinside the amalgam 1, has its second electric lead 7 connected with the terminal pin 8 of the lamp, which terminal pin, in its turn, is connected to the first terminal 12 of a power supply source. The first lead 6 of the electric heater 3 is electrically connected to the metal housing 5 of the end cap of the lamp, which housing is connected through a temperature-responsive control means 13 to the other terminal 14 of the power supply source. The other terminal pin 10 of the base portion 4 of the lamp is connected to a starting device 15 which is adapted to ignite the herein disclosed fluor-

escent lamp. The starting device 15 is serially connected between the terminal 10 and the first terminal pin 16 of the other base 17 of the lamp. The other terminal pin 18 of the base 17 is connected to the terminal 14 of the power supply source through a ballast 19, which ballast is preferably a device featuring sufficient electric inductance. The terminal pins 8, 10 of the base 4 and the terminal pins 16, 18 of the other base 17 of the lamp are connected, respectively, with the first emissive internal electrode 20 and the second emissive internal electrode 21 of the lamp.

As it has been already mentioned, the current flowing through and energising the electric heater 3 is controlled in dependence on ambient temperature by the temperature-responsive control means 13 which is preferably a posistor, i.e. a temperature responsive resistor (a thermistor) having a positive temperature coefficient. Alternatively, a thermistor with a negative temperature coefficient in combination with other resistors forming a circuit therewith can be used, as the temperature-responsive current control means 13.

The present invention can be also applied to lamps in which the emissive electrodes are additionally heated in operation, as well as in lamps connected for starter-less ignition, and thus it should be understood that the circuit diagram shown in Figure 2 is intended to serve merely as an illustration.

The ballast 19, the starter 15 and the temperature responsive control means 13 can all be mounted in the fixture which holds the fluorescent lamp. The lamp is preferably provided with a special marking on its base for proper mounting of the lamp in the fixture. It is further desirable that the lamp holder portion of the fixture, connected with the temperature-responsive control means 13, should be also provided with a corresponding marking.

The arrangement shown in Figure 2, which embodies the present invention, operates as follows.

After having been connected electrically, i.e. after having been mounted in the fixture, the lamp is "ignited" by means of the starter 15. The resistance of the temperature-responsive control means 13 is at this moment defined by ambient temperature. If this ambient temperature, and, consequently, the temperature of the lamp and of the control means 13, is high (i.e. is near to the upper limit of the range of the operating temperatures of the lamp), the electric resistance of the temperature-responsive control means 13 is also high, and only a relatively small electric current flows through the heating means 3, so that the heater virtually does not affect the temperature of the amalgam 1, whose temperature is just above ambient temperature. Under these conditions the composition of the amalgam should provide for optimum pressure of the mercury vapour in the lamp, which is attained by preparing the amalgam composition correspondingly. Should now the ambient temperature drop, the electric resistance of the temperature-responsive control means 13 drops accordingly, and a greater current starts flowing through the heating means 3. The greater the current, the lower the ambient temperature, as compared with the temperature at which the small current flowing through the heating means 3 does not affect the temperature of the amalgam, as has been already described. Thus, it is preferable for the characteristics of the temperature-responsive control means 13 to provide for the output of the heater 3 to be such as to maintain a practically constant temperature of the amalgam 1, when the ambient temperature varies within a predetermined range to be found in practice. In this way the mercury vapour pressure inside the lamp can be maintained at a predetermined level, providing for maximum light output of the lamp.

Figure 3 illustrates the relationship between the light output of a fluorescent lamp and the ambient temperature in three cases, namely, for a lamp constructed in accordance with the present invention, for a mercury vapour lamp without any mercury amalgam, and, finally, for a lamp having mercury amalgam, but having no means for heating these mercury amalgam. Figure 3 shows this relationship in terms of percentage of maximum light output versus temperature. The curve "a" corresponds to a lamp having no mercury amalgam. It can be seen that the maximum light output of this lamp corresponds to 20°C and drops noticeably at ambient temperatures both below and above this optimum value. The curve "b" corresponds to a lamp having a mercury amalgam but having no means for heating the latter. This lamp displays a maximum light output at an ambient temperature of about 40°C, this output dropping considerably at temperatures both below and in excess of about 40°C. The curve "c" in its turn, corresponds to a fluorescent lamp having a quantity of a mercury amalgam and a heater for the amalgam controlled in accordance with the present invention, the composition of this amalgam being selected so as to provide for the light output of the lamp being at its maximum at an ambient temperature of about 55°C, without heating of the amalgam. It should be borne in mind that in the last-described case any further increase of the ambient temperature would inevitably lead to the light output of the lamp dropping. The composition of the amalgam is preferably selected so that the light output of the lamp is at its maximum at the highest possible operating temperature of the lamp.

In this case when the ambient temperature falls below this highest value, the amalgam heater starts its operation, whereby the light output remains constant. This situation changes only when the ambient temperature is so low that the mercury vapour pressure within the lamp starts being dependent on the amount of mercury vaporized from the amalgam and condensed on the walls of the glass envelope, which leads to the light output of the lamp dropping. With this fact being taken into consideration, the present invention is most advantageous when applied to such types and sizes of fluorescent lamps operating at such ambient temperatures that the coolest portion of the lamp in operation is not cooler than 25°C. The last mentioned temperature is responsible for the light output of the lamp dropping by no more than 10 per cent of the maximum value.

The efficiency of a fluorescent lamp, constructed and controlled in accordance with the present invention depends, in practice, on the variation of the ambient temperature in the same way as does the light output of the lamp. This can be explained by the power required for heating the amalgam being very small, as it has been already stated. Thus, for a 100 W lamp the power required for heating the amalgam is not more than 3W.

WHAT WE CLAIM IS:—

1. A fluorescent lamp apparatus comprising a fluorescent lamp including a quantity of an amalgam disposed within a stem, an electric heater for heating the amalgam and surrounding the stem and an end cap in which said heater is disposed; and control means for controlling the electric current flowing through said heater in accordance with the variations of the ambient temperature.

2. A fluorescent lamp apparatus as claimed in Claim 1, wherein the end cap comprises a base to which a metal housing is joined, one electric lead of said heater being connected to the metal housing, and another electric lead of said heater being connected to a terminal pin carried by said base.

3. A fluorescent lamp apparatus as claimed in Claim 1 or Claim 2 wherein, when energised, the coldest part of the lamp is at a temperature of at least 25°C at the lowest ambient temperature in which the lamp is designed to operate.

4. A fluorescent lamp apparatus substantially as hereinbefore described with reference to the accompanying drawings.

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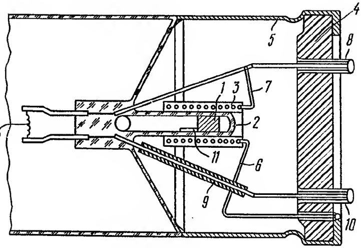

FIG.1

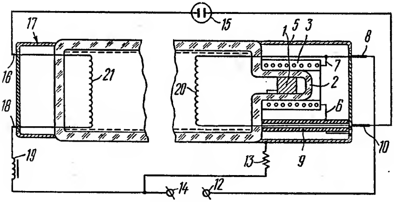

FIG. 2

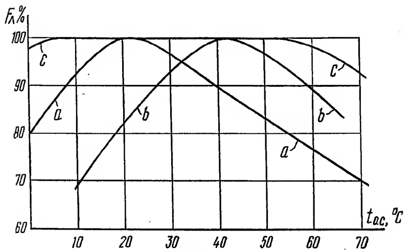

FIG. 3